Title

METHOD OF MAKING AUTOMOTIVE PARTS HAVING SPLINE

Prior Applications

This application claims priority to provisional application serial number 60/412,654, filed September 20, 2002.

Field of the Invention

[0001] The present invention relates to the field of automotive parts. Particularly, the present invention is directed to a method of making automotive parts having an interior spline through the use of a metal forming process.

Background of the Invention

[0002] In the automotive field, parts having splines are particularly useful in creating interlocking articles or other useful features in automotive parts. Previously, automotive parts having one or more splines needed to be manufactured in a series of main steps—most typically, forging, turning, pressing, refining and broaching. In the forging step, a rod member is cut, heated, shaped and trimmed to prepare a basic form of the spline part. In the final broaching step, splines are then cut into the interior of the part through the use of a spline broach. For example, U.S. Patent 2,726,435 discloses a

reciprocating broach, used to make particularized shapes on the interior of a bore, wherein the broach possesses multiple axially aligned cutting teeth. This spline broach, along with many others known in the art, is problematic for automotive parts requiring a durable, high-strength spline because splines formed by such broach are often defective at a rate that is unacceptable to the automotive industry. More generally, spline broaches are relatively unsuitable for small-sized splines. Lastly, the cutting action of the broach itself possess substantial hazards to the safety of those making the splines as well as to the quality of the part being broached (for example, in the event that the cutting broach fails or the point of contact for the reciprocating action is inconsistent during the process).

[0003] Thus, it would be advantageous to form high-strength splines in automotive parts in a manner that displaces, rather than cuts, the metal—thereby resulting in superior quality splines in comparison to previously known spline-cutting methods.

Summary of the Invention

[0004] The present invention is directed to a method of manufacturing an automotive part including a spline. The method includes forging an automotive part. Preferably, the automotive part includes a bore. The method further includes machining the part and the bore. The method further includes pressing a spline tool into the machined bore. The spline tool includes one or more spline grooves. Preferably, the

width or diameter of the tool is equal to or greater than the width or diameter of the bore. The pressing of the tool into the bore displaces the metal along an interior axis of the bore, thereby creating one or more splines (depending upon the shape of the tool). Preferably, the automotive part is formed from a high strength metal, such as a steel alloy with relatively high carbon content, preferably at least 0.5-1.0%.

[0005] Still other advantages and benefits of the invention will become apparent to those skilled in the art upon a reading and understanding of the following detailed description.

Brief Description of the Drawings

[0006] The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment and method of which will be described in detail in this specification and illustrated in the accompanying drawings that form a part hereof, and wherein:

[0007] FIGURE 1 shows a cross-section of an automotive part **10** and a spline tool **14** where the tool **14** is being pushed in to the bore **12** of the part **10**.

[0008] FIGURE 2 shows a perspective view of a preferred embodiment wheel spindle **20**.

[0009] FIGURE 3 shows a perspective view of a terminal end of a spline tool **14** having two spline grooves **18**.

Detailed Description of the Preferred Embodiment

[00010] The present invention is directed to a method for manufacturing an automotive part having a spline. The method includes forging an automotive part, where the automotive part defines a bore. The method further includes machining the automotive part and bore to a desired shape. The method also includes pressing a tool including at least one spline groove into the bore with sufficient force so that the tool forms a spline on the inner portion of the part in the bore.

[00011] FIGURE 1 shows an automotive part **10** defining a bore **12**. A spline tool **14** is pushed towards the automotive part **10**. The bottom **16** of the spline tool **14** that first contacts the automotive part **10** has a diameter equal to or greater than the width or diameter of the bore. Thus, the bottom **16** of the spline tool **14** contacts the inner edge of the automotive part **10** that defines the bore **12**.

[00012] The spline tool **14** includes one or more spline grooves **18**. In the spline tool shown in FIGURE 1, the spline tool **14** includes two spline grooves **18**. The spline

grooves **18** are generally recessed so that when the tool **14** machines the bore **12** of the part **10**, a spline is formed on the inner portion of the part **10** defining the bore.

[00013] In operation, when the spline tool **14** is pressed into the bore **12** of the automotive part **10**, the tool **14** forms the metal of the part **10** in such a manner that carves away or shaves out a portion of the material forming the inner portion of automotive part **10** and defining the bore **12**. Notably, the metal forming process accomplished by the tool **14** occurs in a single downward movement relative to the part **10**, thereby eliminating any need to have the tool **14** reciprocate during the metal forming process. Splines are formed on the inner portion of the part **10** defining the bore **12** in a pattern which mirrors the spline grooves **18** of tool **14**.

[00014] The spline grooves **18** are preferably formed at a terminal end of the tool **14**. The number of grooves may vary according to the type of automotive part **10** being manufactured. However, as best illustrated in FIGURES 1 and 3, it is anticipated that a tool **14** having two grooves **18** which commence at a terminal end of the tool **14** and run parallel to one another along only an axial portion of the tool **14** (rather than the entire axial length of the tool **14**) will be a preferred embodiment.

[00015] Any automotive part that requires the machining of a spline is contemplated in the present invention. Preferably, the automotive part formed with the present method is a wheel spindle, although of course other automotive parts are contemplated. FIGURE 2 shows the preferred wheel spindle **20** that defines a bore **22**

along its longitudinal axis. Preferably, the automotive part formed with the present method defines an aperture or bore. The spline is formed on the automotive part in the bore. The bore is generally cylindrical although other shapes are contemplated.

[00016] The automotive part is formed from a steel alloy material. Preferably, the material forming the part includes a relatively high amount of carbon in the range of from about 0.5% to about 1.0% by weight. Generally, carbon in amount greater than 2% by weight should be avoided because such a high amount of carbon forms an iron exhibiting undesirably high brittleness properties.

[00017] The spline tool is generally cylindrically shaped, although other shapes are contemplated. Preferably, the shape of the spline tool will be the same as the shape of the bore. The tool includes one or more spline grooves. FIGURE 3 shows the bottom of a spline tool **14** having two spline grooves **18**; however, the spline grooves can be of any shape depending on the desired shape of the final spline formed in the automotive part. The inner width or diameter of the tool **14** is preferably greater than the width or diameter of the bore, whereas the outer diameter of the tool **14** must allow for appropriate contact between the tool **14** and the part **10** during the pressing, or metal forming, part of the process. The inner diameter is defined by the narrowest width of the tool (for example, as shown in FIGURE 3, from one edge of the spline groove **18** to the opposite edge along the bottom end **16**), while the outer diameter represents the thickest width of the tool **14**.

[00018] The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon a reading and understanding of this specification. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.